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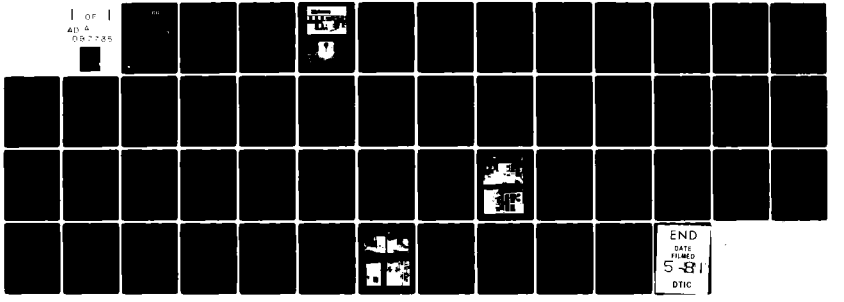

AFGL-TR-80-0372

LEVEL II

12

SUPPORT OF AFGL BALLOON TELEMETRY SYSTEM

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Final Report
1 January 1978 - 31 July 1980

30 September 1980

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AIR FORCE GEOPHYSICS LABORATORY
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
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20 ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Physical Science Laboratory (PSL) of the New Mexico State University (NMSU) provided support for the Air Force Geophysics Laboratory (AFGL) balloon telemetry systems. Support included updating and modifying existing land-based and mobile telemetry facilities located at Holloman AFB. Software was generated to utilize these facilities during computer-supported balloon operations. Operational support was provided during these balloon tests for pre-flight, real-time, and post-flight test activities.

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FRONTISPIECE

FOREWORD

This document, Final Report, was prepared by the Physical Science Laboratory (PSL) of New Mexico State University (NMSU). It is submitted to the Electronic Systems Division (PPR), Air Force System Command, USAF for the support of AFGL balloon telemetry systems. The support consists of engineering, instrumentation, system integration, and test support for updating and modifying existing Air Force Geophysics Laboratory (AFGL) mobile and land-based station telemetry facilities during computer-supported balloon operations. This report was prepared under Contract F19628-78-C-0070 and submitted in specific response to the Contract Data Requirements List (CDRL) Line Item 103.

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1.0 INTRODUCTION

1.1 Contract Statement of Work

The AFGL Contract and its preceeding documents outlined the need and solutions for technical support to AFGL in their high altitude balloon activities. Specific technical support requested included:

- Modifications of an existing mobile telemetry van to accept computer based PCM ground station.
- Design and fabricate special telemetry interface devices and integrate them with standard PCM and computer equipment for use in a Mobile Van.
- Update (hardware and software) AFGL's balloon reception base station at Holloman AFB, Building 850 for completion with the updated mobile telemetry van.
- Operate the AFGL facilities to support computer/PCM dependant balloon flights.

The above work included specific technical and operational objectives. The mobile telemetry facility (van) was to contain a computer based telemetry station using a DEC PDP-11/10 minicomputer and peripherals and standard EMR telemetry equipment. Reception and recording were to include an analog recorder and various antennas, receivers, strip chart recorders, etc. A special interface and software was to be fabricated to permit the received telemetry data to be routed in to the computer for real-time acquisition, processing, recording, and display.

The primary base station located in Building 850, HAFB also required update so it would be compatible with the mobile system. Such compatibility was to include both hardware, data media, and software.

The final technical requirement was to provide operational support to AFGL for all pre-launch and in-flight balloon operations requiring computer/telemetry systems support. This included both the base

station and mobile van. This operational support was to include the development of special software support to the cognizant scientist. Such software development was to be based on specific algorithms provided by the using scientist.

In order to adequately propose the level of effort that may be required, the RFP included man-power estimates. These estimates were:

- Principal Investigator 1/2 Man-year
- Electronic Engineer 1/2 Man-year
- Technician 1 Man-year
- Analyst 2 Man-year

The above were the basis for the subsequent PSL proposal and awarded contract labor.

Operational support was to be provided to not only HAFB, but to various remote sites. Also included were travel to technical reviews at locations such as AFGL. An estimate of such travel was set forth in the RFP to be:

- Watertown, South Dakota - Two (2), two (2) week field expeditions, each with two (2) people.
- AFGL, Hanscom AFB - Four (4), one (1) person trip for technical and administration coordination.
- Patrick AFB, Florida - One (1), two (2) week field expedition for one (1) person.
- Holloman AFB, New Mexico - Local transportation to total approximately 10,000 miles.

The above general and specific balloon support requirements were used in the preparation of the PSL proposal and subsequent contract performance. Minor variations in the estimates did occur during the contract performance. All preformance activities were coordinated with the AFGL Contract Manager.

1.2 Contract Administrative Summary

The AFSC contract F19628-78-C-0070 was issued by the Department of the Air Force, Headquarters Electronic Systems Division (AFSC), Hanscom Air Force Base (AFB), Massachusetts. The contract was awarded to the Physical Science Laboratory (PSL) of New Mexico State University (NMSU) on 1 January 1978 and was based on the PSL Proposal (78-AF-39) for support of AFGL Telemetry System(s). The PSL proposal, submitted in November 1977, was prepared in response to the USAF Request for Proposals (RFP) F19628-77-R-0356. The RFP (F19628-77-R-0356) was issued 19 October 1977 with all responses due on 11 November 1977.

The awarded contract contained a priority rating of DO-A7 with ONRRR, Tucson, AZ, appointed as the Adminstrative Contracting Officer. The sponsor of the work to be accomplished was the Air Force Geophysics Laboratory (AFGL), Air Force Systems Command. The principal invetigator for PSL was J. Craig Erickson who provided direct supervision for all contract related activities. The government's Laboratory Contract Manager was Mr. Arthur A. Giannetti with his alternate being Mr. Alan R. Griffin. Both government management personnel were located at AFGL (LCC), Hanscom, AFB.

At the award of the contract, it outlined a 24 month schedule, with the work completion date established to be 1 January 1980. A three month phase to prepare the final documentation placed the expiration date at 31 March 1980. An amendment (P00002) changed the work completion date from that originally established to 13 April 1980 and the contract expiration from 31 March to 13 July 1980. This represented an extension of 105 days. The contract schedule was further extended by 60 days by contract modification P00003; work completion on 14 June with contract expiration on 14 September 1980. At the request of PSL, the schedule was once again re-adjusted for work completion 30 July 1980 and expiration on 30 September 1980.

The awarded contract was cost reimbursement type with incremented funding during the period of performance.

The contract was modified four times during its existance. These modifications were:

- A00001 issued 1 September 1978 - Changed Administrative Contracting Officer.
- P00001 issued 1 October 1978 - Incremental funding.
- P00002 issued 1 October 1979 - Incremental funding; extended contract expiration date date 105 days.
- A00002 issued 9 January 1980 to revise Contracting Officer information.

The modifications A00001 and A00002 were issued by the Administrative Contracting Officer and Modification P00001 and P00002 were issued by Hanscom, AFB.

2.0 CONTRACT FINANCIAL SUMMARY

The AFGL contract outlined a two year technical support activity and a corresponding cost estimate. The awarded ceiling value of the contract was $165,169. On its initial award (1 January 1978) it was funded $73,250. The contract modification P00001, (November 1978) increased the funded amount by $47,000 to a total of $120,250. In November 1979, the contract was modified (P00002) with an increase in funding of $44,919. The fund increment fully funded the contract to its ceiling of $165,169.

The original cost estimates submitted by PSL with the technical proposal were composed of the following catagories:

Labor: 8,300 man-hours;	$146,990	
Travel:	15,704	
Supplies, Communications, etc.	2,475	
Total Cost Estimate		$165,169

The cost estimates were distributed over the 27 months succeeding the contract award. Specific analysis of the estimated costs versus the actual expenditures are presented in detail in the following paragraphs.

Table I presents the planned expenditure of manhours and total funding. It notes that the program was extended four months without additional funding. Table II presents the total actual and planned manhours expended through July 1980. It shows that 111% of the planned manhours was expended. However, Table III which shows the total actual and planned funding expenditure, notes that 97.3% of the funds were used. Figures 1 and 2 present the manhours and funding expenditure graphically. Figure 3 shows detailed manhour expenditure by the type of employee. These data shows that the program was conducted within the dollar budget even though the manhour budget was exceeded.

3.0 TECHNICAL SUPPORT

3.1 General

The PSL activities on the AFGL contract encompassed two primary areas: system update and operations. The base station at Holloman AFB (Building 850) as well as the mobile facility were the focal point for all PSL support.

The activities at Building 850 were a continuation of similar efforts performed by PSL prior to the award of the subject contract. The base station had been in existance for many years and represented a very powerful telemetry station which included PCM, PAM, and FM/FM capabilities. An antenna system permitted manual pointing of a wideband and a narrow band receiving antenna and standard telemetry RF receivers. Depending on the operational requirements, data could be displayed on analog strip chart recorders, analog meters, analog recorders, etc. The station was manual and its capabilities were limited to those features inherent in the telemetry devices.

Prior to the award of this contract, AFGL made a conscious decision to utilize current technology to better support balloon ground data system requirements. The general approach was to utilize a Digital Equipment Corp. (DEC) PDP-11/40 Computer system and accomplish the desired capability via a computer based telemetry system. By all indications, the PCM telemetry form of data transmission was to become the predominate method awaiting balloon payload designers. This, then, was the form around which the new capability was to be established.

The PDP-11/40 and its peripherals were installed and placed operational within the telemetry room of Building 850. A special purpose telemetry interface and a time code receiver/generator had been provided and were installed. A basic system capability had been established prior to the award of this contractual effort.

The preliminary results of such a system were good enough to establish a similar, but more limited capability for mobile remote field locations. This was a part of the technical accomplishments during this contract period.

The general operational philosophy was to first establish a good technical capability and then make it available to the various AFGL customers. General software had been developed, but it was expected that special real-time software would be needed for each unique application. Our role was to insure that the base station was in operational status, the proper application software was developed and to continue to improve the base station capabilities through systematic updates.

The mobile van was the area which was considered to be the first technical objective. A DEC PDP-11/10 was available from other areas within AFGL so it was made available to be used in the mobile van. This resulted in the two systems (Mobile and Base) being very similar except the more limited computational capabilities of the PDP-11/10. As a result, the hardware and software assets were interchangeable between the two systems.

The configuration of the telemetry systems continued to evolve throughout the contract period. Improvements were made, both hardware and software, to better respond to the operational and user requirements. Many of the equipment improvements were accomplished by AFGL through the acquisition of new telemetry, recording and digital peripheral devices. These were installed in a manner to fully access their many features and capabilites. Some of the improvements provided by PSL included:

- A telemetry interface for the mobile system.
- A time code reader/generator for the mobile system.
- A telemetry interface for the base station system for dual data streams.
- Patchpanels for the mobile system.

- Integration and testing of the systems components for the mobile system.
- Integration and testing of the base station system components.

At the present time the resulting computer aided telemetry system is capable of supporting most forms of balloon borne data encoding and transmitting techniques. Through actual use, it has identified areas to be considered for future improvements. Section 3.2.1 presents a detailed discussion of the actual base station configuration as it currently exists.

Although not used as extensively, the mobile facility has proven its value in remote launch operations. The configuration of the various telemetry systems is presented in Section 3.2.2.

The software aspects of this contract performance and, indeed in the operations of the two telemetry system, was the most significant accomplishment. Special software was developed as the baseline package which could be utilized as the "foundation" for all special applications. There were many specific operations for which PSL developed the "special" application routines. These usually consisted of algorithms to process selected data and then it's display. Section 3.2.3 of this document addresses these various software accomplishments.

As a general summary (Section 4.0), from our perspective, the development plan outlined for upgrading the balloon ground support data facilities at HAFB has been very successful. It has provided data in new forms with greater update rates than has ever been experienced in the past.

The analog display and recording capabilities have not been downgraded, and are available to be used. In fact, the user requirements have not been a total computer aided display, but a combination of the two. The more complex processed data is handled by the computer where straight parameter display utilize the analog features of the system.

As is the case for any state-of-the-art system, there are always improvements which can be identified and the AFGL, HAFB system is no exception. The capabilities of the system can now logically occur to keep pace with the ever increasing sophistication of balloon bourne instrumentation. The on-board recording techniques are becoming obsolete in the more advanced balloon payload systems. Recording capabilities are becoming increasingly more important to "capture" the data. Post flight data quick-look phases usually involve computer added processing as the raw data becomes complex in its representations.

More complex uplink command systems are a feature that would be highly desirable for the types of balloon bourne control systems. Such systems have very complicated sequences composed of many different command formats. Even uplink of computer programs to "on-board" computers are becoming more common. These suggested improvements and others are discussed in Section 5.0.

3.2 Work Accomplishments

The technical accomplishments by PSL during this contract period are discussed in this section. For convience, the information is subdivided into the following areas:

Base Station Facilities
Mobile Facilities
Software
Travel/Field Expeditions

3.2.1 Base Facilities

The primary ground data support for balloon operatiors occur at the AFGL facilities located in Building 850, Holloman Air Force Base (HAFB), New Mexico. The facilities are further subdivided into functional operational areas such as a control center, weather, and among others, a telemetry room. Most of the PSL activities under this contract occurred on the stem located in the telemetry room.

The telemetry system located in the telemetry room is an integrated complex of computer, PCM, PAM, FM/FM and analog devices. The computer-based capabilities extend only to the PCM devices. A picture of this facility is shown in Figure 4.

The purpose of the existance of the AFGL facilities at HAFB is to support the various high altitude balloon operations. Remote off-site operations are also supported using a subset of the primary facility capabilities. The normal balloon operations differ greatly from one user to another. The variances usually lie within the range of accepted PCM data transmission and formats. The support facility is configured to permit these variations and to be able to accommodate all users. Of course, many operations do not require such ground support since they may have on-board recording or have little need for real-time display.

The computer based PCM capabilities are for those users who have a need for monitoring the on-board instrumentation performance and/or resulting data so they may make in-flight changes. This need is satisfied by pre-programming the computer and various PCM equipment to extract, convert and display the critical data. In-flight changes are usually accomplished via the uplink command system (independent of computer control) and/or actual balloon flight control.

An extension to the support for such real-time needs are those for the pre- and post-test phases. Prior to the launch, careful interface testing occurs as well as on-board-instrumentation operational evaluations. These pre-flight tests are supported with the telemetry system using the normal "real-time" programs and/or special pre-test programs.

Following a flight operation where the computer is involved, the user often requires post-flight selected data display for on-site flight success evaluation. Additionally, the user may require the conversion of in-flight data from one media to another. This usually facilitates the more indepth analysis at their respective facilities. These post-flight transcriptions are a standard part of the capabilities of the station.

The telemetry system consists of many inter-related units, where the total is capable of:

- Reception of RF signals
- PCM Decomutation
- FM/FM data conversion
- Analog data recording and display
- Computer system

The above areas are integrated together to permit rapid reconfiguration from one type to another. Functionally, they are configured as shown in Figure 5. The displays are used by the various balloon flight control personnel as well as the project scientist/engineer to effect changes to better shape the succeeding flight profile and on-board payload activities. In all cases such control is effected through the uplink command system.

The receiving subsystem is functionally shown in Figure 6. Information is received by two RF antennas: a high gain and a low gain antenna. The received signals are routed to the receivers through multicoupler using pre-amplifiers to overcome the cable losses and low signal levels. Two receivers are used to discern the signals from each antenna. The antennas themselves are co-located on a single mount manually controlled from the telemetry room. The manual steering is optimized by monitoring the received signal level.

The command uplink antenna is mounted on a separate steerable antenna. The antenna type and transmitted power levels result in a normally fixed antenna orientation.

A fifth receiver is used to receive information for WSMR telemetry facilities.

The PCM capabilities of the telemetry room are the feature most utilized in balloon operations. A functional diagram of the PCM subsystem are shown in Figure 7. The subsystem provides for dual link reception and processing. The units involved are EMR devices

with the formatting device being PSL provided.

Two data streams can be received and presented to the computer for real-time processing. Using the capabilities of the EMR units, selected PCM information can be converted to analog form and routed to the analog display devices without computer assistance. Each PCM unit is capable of being "programmed" (by front panel access, computer and/or cards) to accomodate a wide range of PCM formats, rates, etc.

A special PSL Time Code Reader/Generator has been provided by PSL to permit accurate time-tagging of the data sent to the computer. Such time-tagging processes can utilize any standard IRIG source.

Because the PCM devices of the telemetry system are the most utilized, a cable configuration drawing is shown in Figure 8.

The computer subsystem configuration is shown in Figure 9. The CPU is a DEC PDP-11/40 with several peripherals necessary for software development and real-time control/display. Currently the PDP-11/40 is implemented with 32K (K = 1,024) words (16 bits per word), and the extended instruction set. THe UNIBUS is used to communicate with all peripheral devices.

Two disk drives are included in the computer configuration to permit software development program execution. The second unit enables on-site media copying for generating backup copies of data and disk resident programs. Currently, one or both of the disks are relocated to the mobile van when it is used.

A Pico tape system is used to record digital data from the computer. This recording device is the primary media for exchange of data, programs etc. with other facilities. A second tape system of the same type is used in the mobile van which often requires the use of the base facility tape unit as a backup.

CRT and serial line printer terminals are used for program development, computer program control and as display devices. One printer

and one CRT is located in the Operations Control Center, and one printer and CRT in the Telemetry Room. All real-time computer display output is routed to one or more of these devices. Standard balloon flight characteristics such as; altitude, temperature, pressure, etc. are routed to the operation center display. Payload instrumentation information is routed to the CRT and printer in the Telemetry Room.

Analog display and recording devices are available for the presentation and display of selected tememetry data. These devices include analog recorder(s) used to record the entire data stream received at the station along with timing. Analog displays include meters and strip chart recorders. All inputs (and outputs where applicable) are accessed at system patchpanels.

A set of rack layout drawings for the telemetry room are included with this report for completeness. The drawings included are:

Figure	Rack Drawing
10	Computer
11	PCM Subsystem
12	Telemetry/Receiving
13	Analog Equipment

The above is a brief description of the existing base station configuration. The operational environment is dynamic and as a result the configuration may routinely change. System components are often removed to support the requirements of the mobile van and other field expeditions, as well as additional equipment augmenting the existing base station configuration. These changes are often accomodated through the many patchpanels throughout the system.

3.2.2 Mobile Telemetry Facility

A second major endeavor under this contract was the establishment of a more limited telemetry system in a mobile van. This mobile capability enabled computer assisted telemetry support to those requiring such capabilities in a remote field launch environment. The mobile facility was configured from existing AFGL assests and has subsequently been used on several field operations. A picture of the mobile facility is presented in Figure 14.

The system located within the van is configured for PCM telemetry data reception, processing and display. A DEC PDP-11/10 Computer with peripherals makeup the computer subsystem. Standard EMR PCM telemetry devices provide for the telemetry conditioning. Strip charts and portable analog tape recorder(s) are used for data display and preservation. The overall configuration is similar to the base station but is not as extensive in its capabilities.

The computer system is a PDP-11/10 with 8K (K = 1,024) words of memory. No computer enhancements are included in the processor. A disk interface is embedded in the processor to permit computer access to RK-05 disk(s). Because of limited van usage, the disk(s) used in the base station are used in the van for field operations. Provisions have been made for both disk drives even though only one would be adequate for most operations.

A more limited serial line printer is included in the van to permit computer program control and computer data display. One digital magnetic tape drive and interface are also included in the computer suite for data logging and program exchange media. The computer configuration is presented in Figure 15.

The PCM telemetry subsystem has a single link capability. Input information is received by the antennas and receivers. PCM subsystem output is directed to the computer and/or the analog display devices.

The computer input of PCM data is similar to that method used in the base station. A PSL Time Code Reader/Generator is also included to accomplish the necessary time tagging. A functional diagram of the PCM subsystem is shown in Figure 16.

The analog recording and display capabilities are similar to that of the base station. All inputs (and outputs where applicable) are terminated at patchpanels to permit easy access. The recording devices are those utilized in the base station.

The van is a 32-foot semi-trailer which was constructed to house electronic equipment. As a part of the refurbishment process, PSL overhauled the dual air-conditioning system to increase their reliability. The power distributation was also updated to minimize power transients from adversely affecting the electronic equipment. The interior was also reconditioned as was the exterior. Rack layout drawings for the mobile van are included as Figure 17 for the computer racks and Figure 18 for the telemetry racks.

3.2.3 Software

The key to fully utilizing the new system capabilities lie within the software. This has been a continuing activity throughout this contract period. Programs have been developed for new users and new user requirements as well as a continuing improvement in the baseline routines. All aspects of such programming have been provided including the real-time, pre-test, post-test and data transcription programs.

Until recently, the software development was accomplished under the standard DEC Operating System (OS) entitled RT-11. This OS (RT-11) is very limited in its capability and therefore increases the complexities of the needed programs and reduces their throughput capabilities. Recently the base station computer system has been updated with necessary hardware features to permit utilization of DEC's RSX-11M Operating System. The later operational requirements necessitated the use of RSX-11M to be able to utilize the multi-user (or multi-program) features.

As a general philosophy, the software development was accomplished using FORTRAN, and, where timing was critical, the MARCRO-11 assembler. In most cases the software developed for the PDP-11/40 will not operate on the PDP-11/10 because of the limited hardware features available on the PDP-11/10. Almost all of the software executed on the PDP-11/10 was developed using the more capable PDP-11/40 computer system. The most recent software developments were accomplished on the PSL PDP-11/45 computer system since it has a broader developmental capability. All programs are transportable between these subject computers.

The primary computer programs developed for the AFGL computers include Earl Goods project and BAMM. Both of these projects have had several versions developed as the requirements changed from one mission to another. Various routines of these programs have been used to provide more limited computer data display for other missions conducted at HAFB.

Details of these programs are on file at the HAFB and are not repeated here. Various archive copies have been made to minimize inadvertant unrecoverable losses.

In addition to the software developed for use on the PDP-11/40 and PDP-11/10 systems, specific requirements have also resulted in a series of programs developed for the PDP-11/45. The latter programs were to accomplish rapid responses on the transcription of pre-recorded PCM telemetry data. Such data was extracted from analog recordings and was converted to digital form. These programs were developed for both Earl Good's data as well as a special BAMM mission. Once these programs were developed, turn-around times of 24 hours were easily accomplished. These programs are on file at PSL for future utilization.

3.2.4 Field Support

A part of the performance of this contract was to provide support to AFGL in HAFB missions as well as remote field missions. Several such field expeditions were supported using the mobile telemetry

van. In general, several Earl Good missions and BAMM were supported. These expeditions were physically located in Arizona, South Dakota and Florida. In all cases the performance of such capabilities were considered successful.

In some expeditions, especially the Florida mission, they were supported using PSL and other project equipment. A routine process such as this enables maximum utilization of government equipment on a not-to-interfere-basis. In some cases complete telemetry vans were borrowed and in other missions vary levels of telemetry systems were borrowed.

These various field expeditions have been described in previous reports, so the details are not repeated here.

4.0 SUMMARY

The accomplishments under this contract have been many; perhaps the most important one being the establishment of a routine computer aided ground system support. The original objective was to establish a system/configuration to permit this user freedom in helping to fulfill his research needs. At the conclusion of this contract such a capability exists.

Improvements have been set forth to continue this technology advancement at HAFB. Todays balloon borne instrumentation systems have been rapidly advancing as have the flight duration and payload complexities. The use of mircoprocessors, multi-data stream, multi-frequencys, and high data rates are characteristics of these new imporovements. The ground station must keep pace with these advances so as not to obsolete itself on the threshold of success. Complex missions are now easily accomodated.

5.0 RECOMMENDATIONS

Recommendations are always easy to identify in dynamic and broadly utilized systems such as the Building 850 and mobile system. A well prepared improvement plan must consider the overall objectives as well as organizational limitations that may be imposed. As a result of our participation with AFGL, there are some recommendations which we feel should be considered and are in concert with what we understand the ultimate objectives to be.

These recommendations are a compilation of specific items and general thoughts. The lists, presented below, are ranked in a general priority:

- A limited inventory of UNIBUS cables and other computer cabling is required to repair intermittent and marginal areas in the PDP-11/40 system.
- RSX-11M is a highly recommended improvement. This will require the following:
  - Full memory implementation of 128K words. If four 32K word/memory boards were acquired, the existing memory could be used as a spare to optimize the mean-time to repair.
  - Licensed RSX-11M OS
- To increase the execution speed, the Floating Point Processor (FPP) is recommended for the PDP-11/40. With the FPP, the FORTRAN IV-PLUS Compiler should be acquired to utilize the FPP feature.
- Replace the existing digital mangetic tape system with units such as those provided by Kennedy, Inc. A two drive configuration would be best in order to provide backup and dual drive features. The existing drives have become obsolete and are most difficult to keep in good repair and are very limited in computer utilization. The replaced units could be used in the mobile van.

- Spare printed circuit boards for the PSL devices would facilitate rapid repair - an essential when committed to operational support.
- A spare EMR 2763 Buffered Data Channel PC board to facilitate rapid repair. The reliability of the 2763 is such that a back-up is very important.
- A color graphics display device for the base station to more effectively display operational data.
- A higher speed printer to enable hardcopy output to be accomplished in a much more expedient manner.

The mobile van utilization has been some what limited of past. Should the demands on such a capability increase, considerations should be given to the following:

- Replace the PDP-11/10 with a more capable computer
- Replace the obsoleted data formatter with the newer versions such as in the base station.
- Acquire at least one, preferably two disk drives.
- Adequate spares for the PSL devices and EMR 2763 interface.

In addition to the above specific recommendations, there are some general areas which are felt to be logical and necessary advancements in the system capabilities:

- Implement a computer based uplink command system
- Establish a CAMAC base as a part or separate from the command system to more easily adapt to the various user input/output requirements.
- Incorporate CAMAC Touchpanel(s) for operation display and control.

The general philosophy of providing individual support to the various users is one of the best ways to make available the full capabilities. Its primary effect is on the software development; tailoring existing software to the new needs and augmenting them with specific mission unique algorithms.

As the system evolves, it can also be setup to be of greater value in assisting with the routing mission planning and reporting. With the establishment of a thorough data base, many statistical and trend effects reporting can be easily accomodated.

TABLE I

AEGL PLANNED CUMULATIVE EXPENDITURE BY QUARTER

QUARTERS	1 JAN 78 - 31 MAR 78	1 APR 78 - 30 JUNE 78	1 JULY 78 - 30 SEPT 78	1 OCT 78 - 31 DEC 78	1 JAN 79 - 31 MAR 79	1 APR 79 - 30 JUNE 79	1 JULY 79 - 30 SEPT 79	1 OCT 79 - 31 DEC 79	1 JAN 80 - * 31 MAR 80
LABOR	(MH - $)	(MH - $)	(MH - $)	(MH - $)	(MH - $)	(MH - $)	(MH - $)	(MH - $)	(MH - $)
Analyst	570 -	1350 - $	1650	2201 - $	2551 - $	2990 - $	3310 - $	3550 - $	3590 - $
Technician 102	260	570 -	825 -	1050 -	1225 -	1500 -	1655	1775 -	1775
Principle Investigator	132	224 -	400 -	520 -	660 -	760 -	832 -	880 -	920
Engineer 105	230	497 -	663 -	786 -	910 -	1036 -	1155 -	1275 -	1275
Procurement Specialist	36	68 -	83 -	88 -	93 -	98 -	108 -	120 -	120
Project Control Manager	36	68 -	93 -	113 -	133 -	153 -	176 -	200 -	220 -
Administrative Secretary	36	69 -	93 -	113 -	133 -	153 -	168 -	180 -	260 -
Drafting	17	36 -	47 -	57 -	67 -	77 -	88 -	100 -	140 -
Total MH/$	1371 - $11,929	2715 - $23,859	3854 - $33,886	4828 - $42,963	5902 - $ 52,038	6725 - $ 61,135	7492 - $ 68,130	8080 - $ 73,115	8330 - $ 75,8[illegible]
FRINGE BENEFITS	$ 4,175	$ 8,351	$11,960	$15,037	$ 18,211	$ 21,399	$ 23,866	$ 25,940	$ 26,556
ALLOCATED DIRECT LABOR	$ 2,335	$ 4,670	$ 6,633	$ 8,410	$ 10,186	$ 11,963	$ 13,333	$ 14,508	$ 14,8[illegible]
OVERHEAD	$ 4,670	$ 9,341	$13,266	$16,820	$ 20,373	$ 23,9[illegible]	$ 26,6[illegible]	$ 29,016	$ 29,70[illegible]
TOTAL LABOR	$23,109	$46,221	$65,645	$83,229	$100,810	$118,391	$131,986	$143,579	$146,99[illegible]
TRAVEL, ETC.	$ 1,684	$ 3,364	$ 4,580	$ 5,562	$ 6,54[illegible]	$ 7,526	$ 9,42[illegible]	$ 11,778	$ 15,20[illegible]
SUPPLY/COMP	$ 265	$ 530	$ 723	$ 876	$ 1,03[illegible]	$ 1,186	$ 1,486	$ 1,856	$ 2,[illegible]79
TOTAL	$25,058	$50,115	$70,948	$89,667	$108,387	$127,106	$142,89[illegible]	[illegible]	[illegible]

*Extended four months without additional funds.

TABLE 11. CUMULATIVE PLANNED AND ACTUAL MAN-HOUR EXPENDITURE BY QUARTERS

	1 Jan. 78 - 31 Mar. 78		1 Apr. 78 - 30 June 78		1 July 78 - 30 Sept. 78		1 Oct. 78 - 31 Dec. 78		1 Jan. 79 - 31 Mar. 79		1 Apr. 79 - 30 June 79		1 July 79 - 30 Sept. 79		1 Oct. 79 - 31 Dec. 79		1 Jan. 80 - 31 Mar. 80		1 Apr. 80 - 30 June 80		1 July 80 -* 31 July 80	
	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A	P	A
[illegible]	579	447	1157	1147	1650	1812	2101	1812	2551	1835	3000	1835	3310	2123	3550	2127	3590	2,189	3590	2671	3590	2875
[illegible]ION	289	0	579	1026	825	2239	1050	2420	1275	2470	1500	2533	1655	2579	1775	2679	1775	2,743	1775	2990	1775	3060
[illegible]ISTRATIVE SUPERVISOR	137	118	274	157	500	220	520	257	640	278	760	278	832	303	880	311	920	311	920	391	920	435
[illegible]	249	31	497	86	663	622	786	733	910	739	1034	843	1155	1068	1275	1125	1275	1,206	1275	1534	1275	1684
[illegible]EMENT SPECIALIST	34	16	68	145	83	200	88	207	93	212	98	212	106	212	120	215	120	215	120	215	120	215
[illegible] MANAGER	34	10	68	70	93	134	113	156	133	159	153	166	176	169	200	175	220	248	220	287	220	319
ADMINISTRATIVE SERVICES	34	46	68	147	93	210	113	231	133	335	153	335	168	344	180	349	260	552	260	568	260	568
[illegible]	17	1	34	10	47	23	57	23	67	23	77	23	88	23	100	23	140	23	140	23	140	23
TOTAL MAN-HOURS	1373	369	2745	2788	3854	5460	4828	5989	5802	6050	6775	6219	7492	6821	8083	7004	8330	7,487	8300	8679	8300	9279**

* One month

** 9179.00 is 11% of the planned man-hours.

[illegible] EXPENDITURES BY QUARTERS

	[illegible] 31 Mar. [illegible]		[illegible]		[illegible]		[illegible]		[illegible] Mar. 79	
	P	A	P	A	P	A	P	A	P	A
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	38,51[illegible]	52,038	34,059
[illegible]	11,18[illegible]	4,199	[illegible]	[illegible]	31,7[illegible]	[illegible],837	40,267	30,8[illegible]	48,7[illegible]	31,418
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	346	530	1,[illegible]	[illegible]	6,653	676	6,826	1,031	7,929
[illegible]	*	2,347	*	5,93[illegible]	*	6,395	*	3,1[illegible]1	*	2,772
[illegible] TOTAL	25,058	12,331	50,115	39,6[illegible]	70,948	81,542	89,667	85,624	108,387	67,533

	1 Apr. 79 - 30 June 79		[illegible] 30 Sept. 79		1 Oct. 79 - 31 Dec. 79		1 Jan. 80 - 31 Mar. 80		1 Apr. 80 - 30 June 80		1 July 80 -** 31 July 80	
	P	A	P	A	P	A	P	A	P	A	P	A
[illegible]	[illegible]1,115	40,387	68,130	45,873	74,115	47,250	75,875	51,507	75,875	62,765	75,875	67,690
[illegible]	57,279	4[illegible],600	63,836	37,290	69,464	36,556	71,115	42,360	71,115	52,780	71,115	57,260
[illegible]	7,526	6,418	9,422	8,450	11,778	10,814	15,704	11,002	15,704	11,185	15,704	11,25[illegible]
[illegible]	1,186	8,732	1,436	9,511	1,856	9,762	2,475	10,906	2,475	20,106	2,475	20,391
[illegible]	*	2,793	*	2,821	*	3,148	*	4,502	*	4,502	*	4,502
[illegible] TOTAL	127,106	90,930	142,894	103,945	157,213	109,530	165,169	120,283	165,169	151,339	165,169	+161,097

* Equipment Expenditures not included in contract proposal, but directed by contractor to be supplied as part of total funding.

** One month only.

\+ $161,097 is 9[illegible]% of Planned Expenditure.

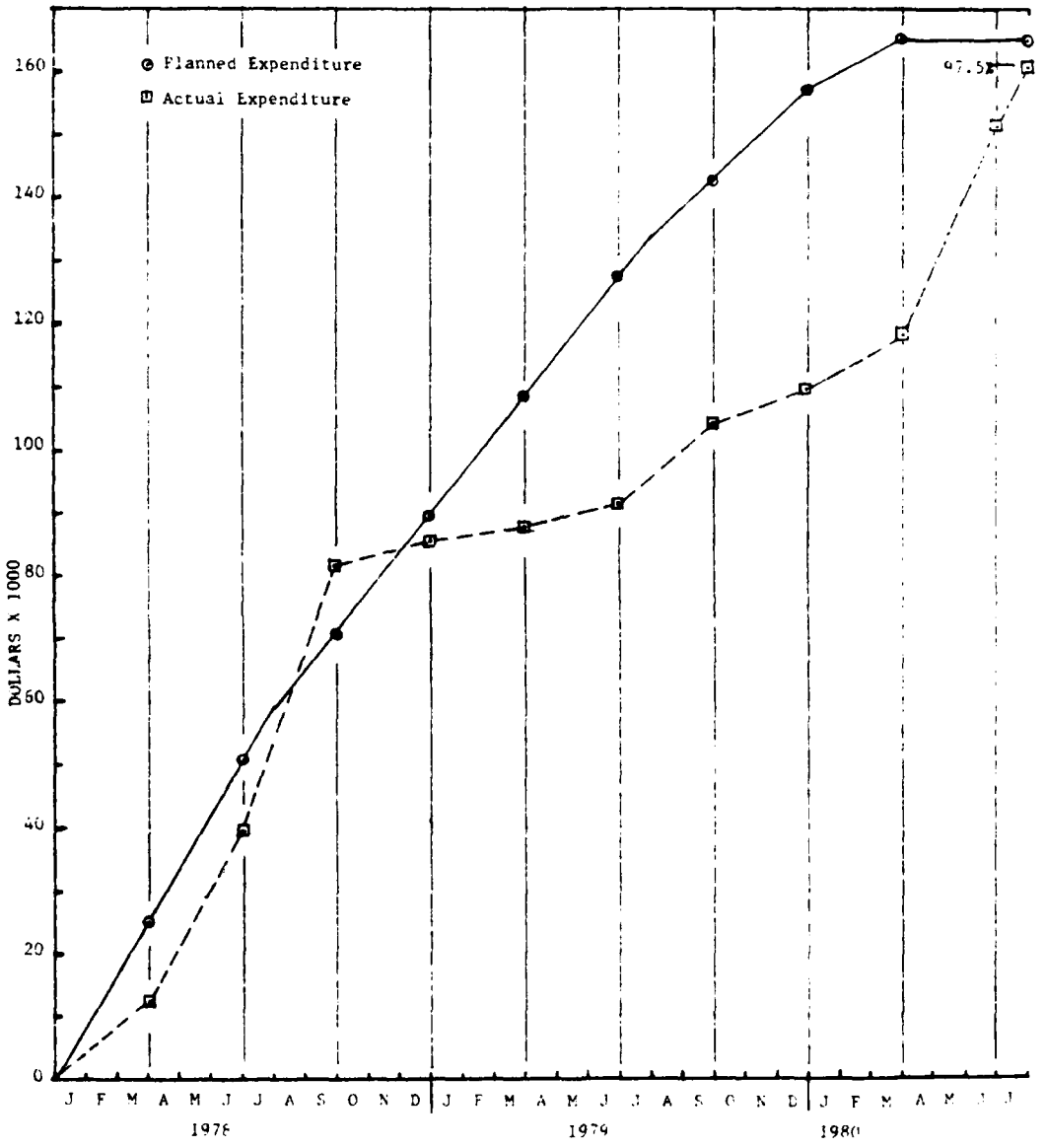

Figure 1. Planned and Actual Fund Expenditure

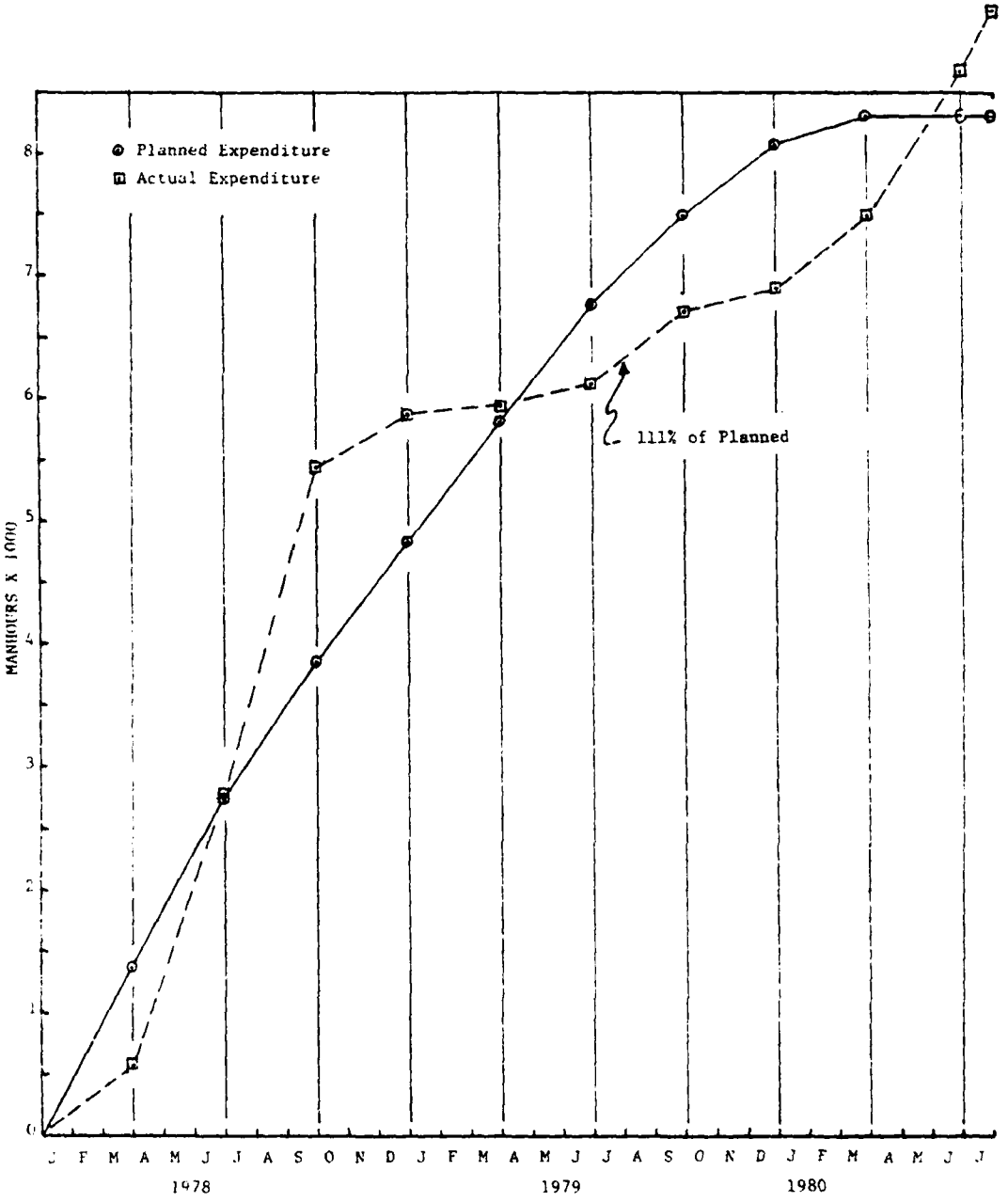

Figure 2. Planned and Actual Manpower Expenditure

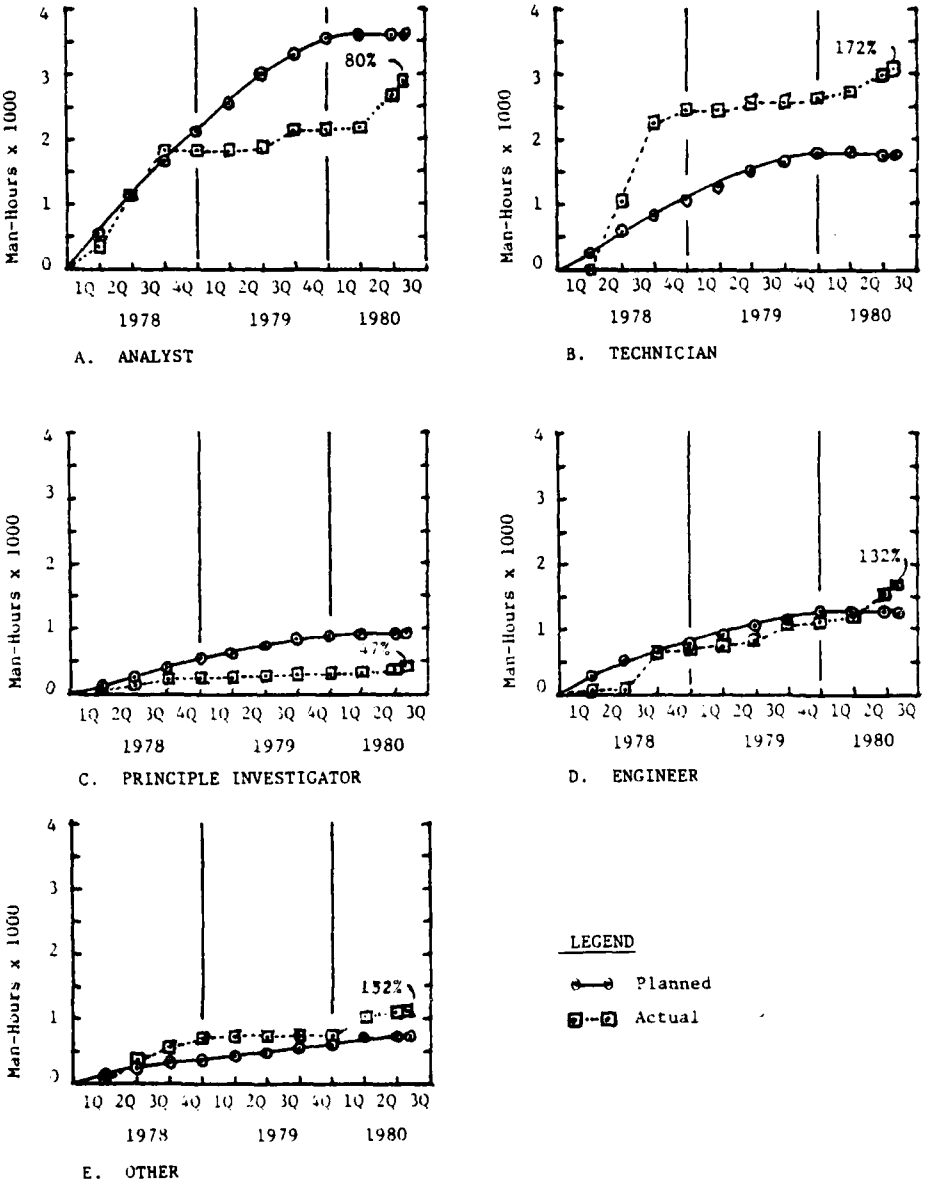

FIGURE 3. Cumulative Planned and Actual Man-Hour Expenditure by Quarters

Figure 4 Base Facility

6.0 DISTRIBUTION

Copy No.	Recipient
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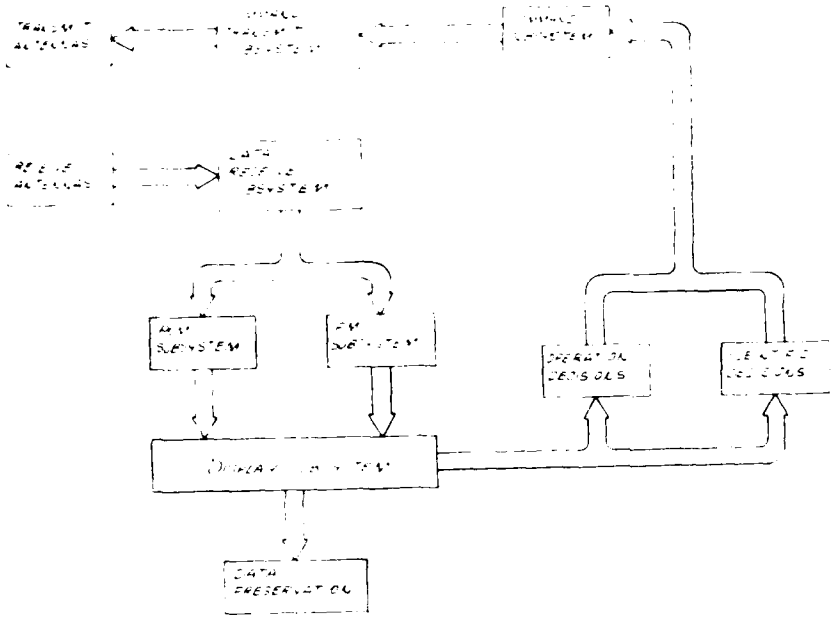
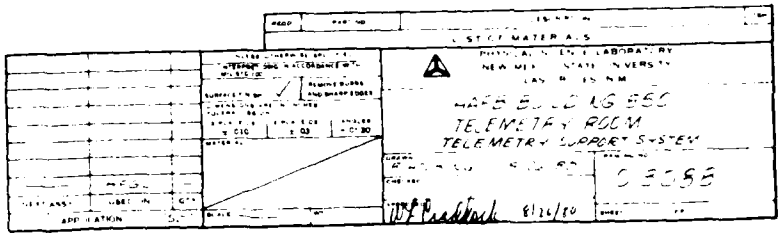
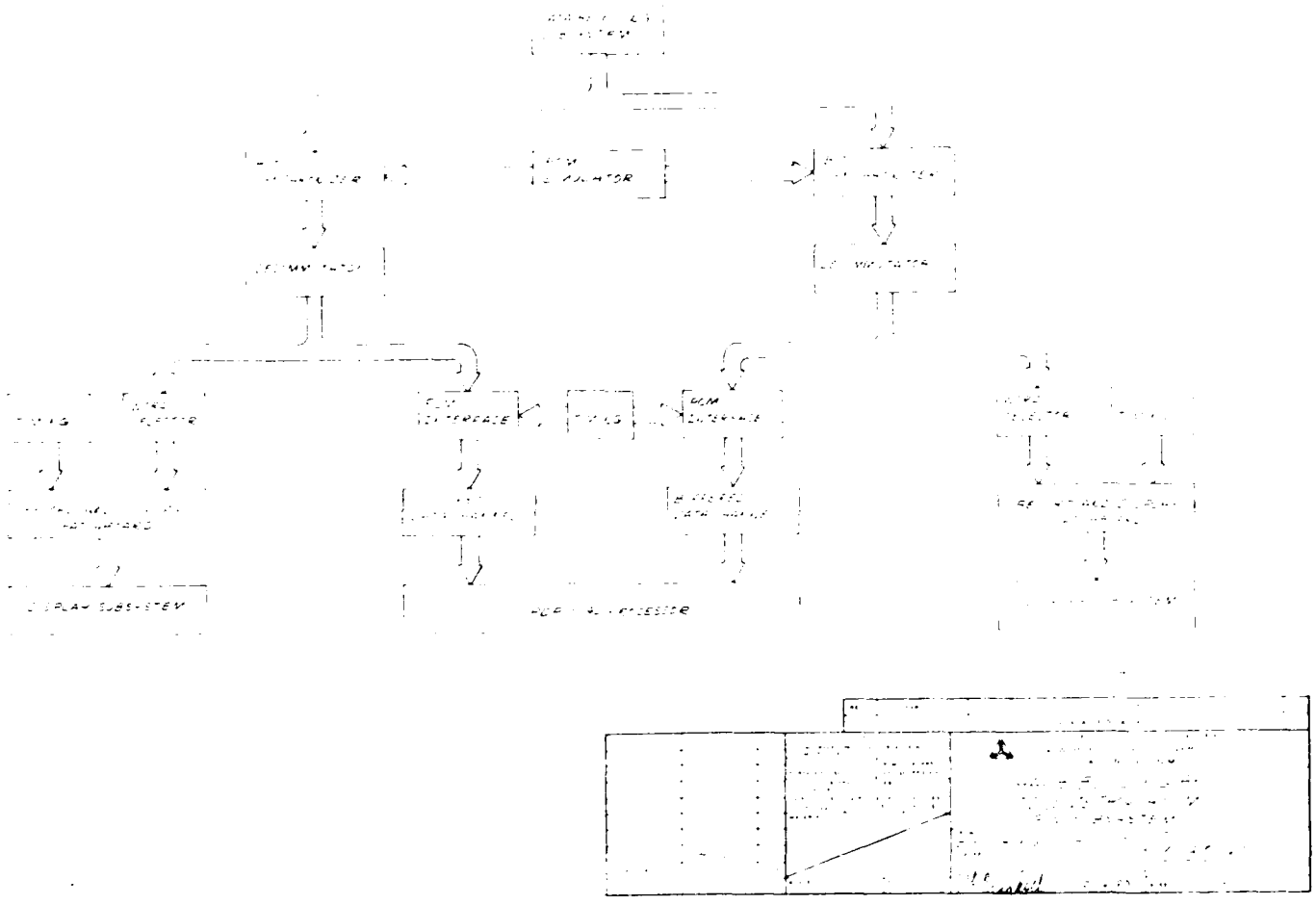
5	PSL - Project Control Office J.W. Hungate
6	PSL - Project Engineer Wade Craddock
7-8	Project File

APPENDIX A

OVERSIZE DRAWINGS




MAPS BUILDING 850
TELEMETRY ROOM
TELEMETRY SUPPORT SYSTEM
C 3085
8/26/80



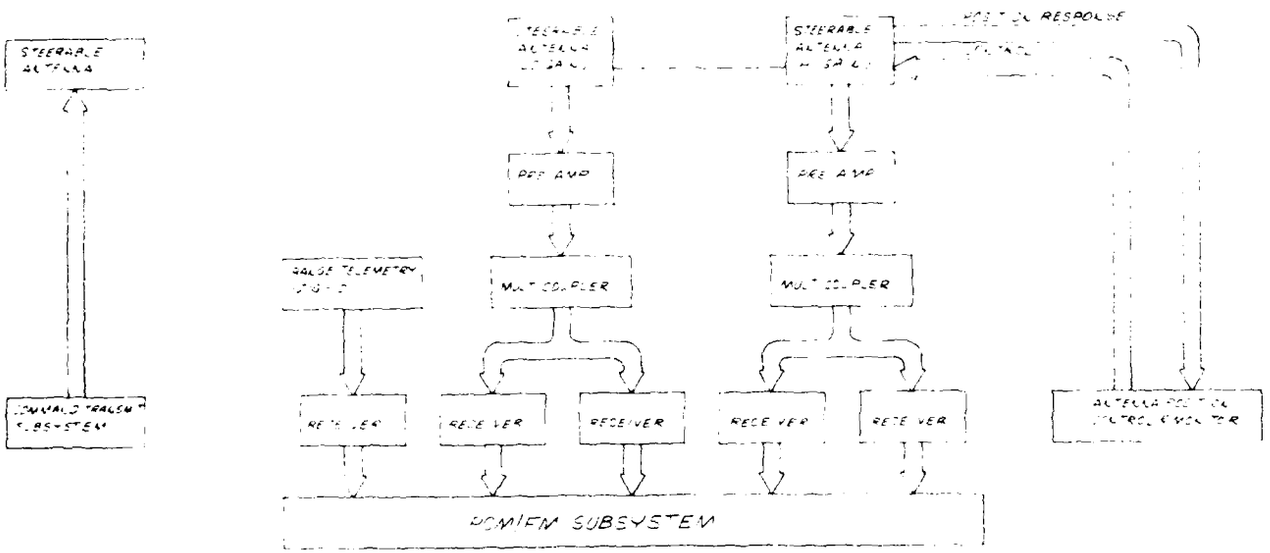
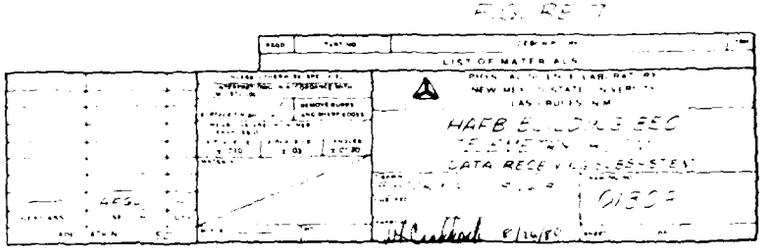
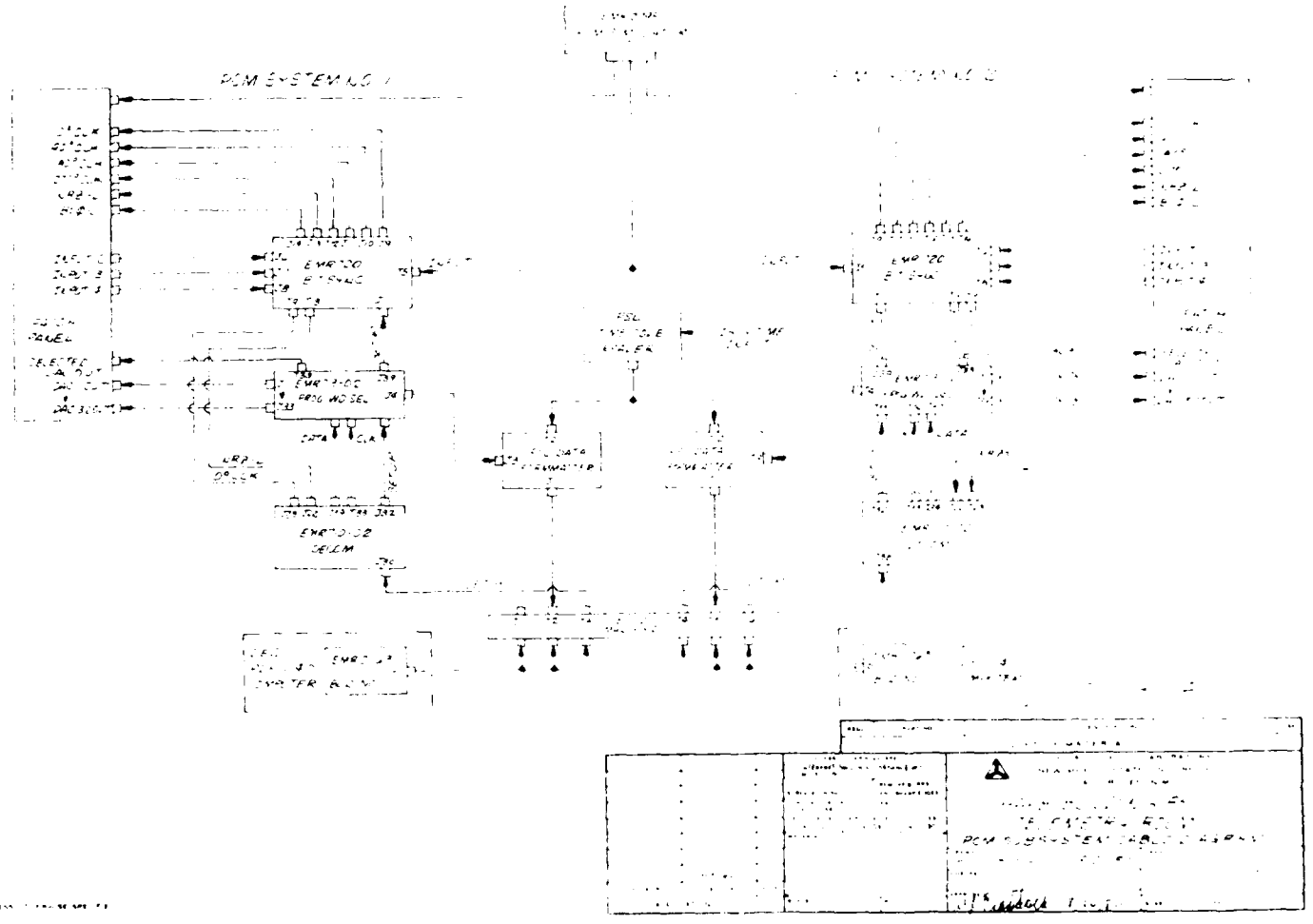
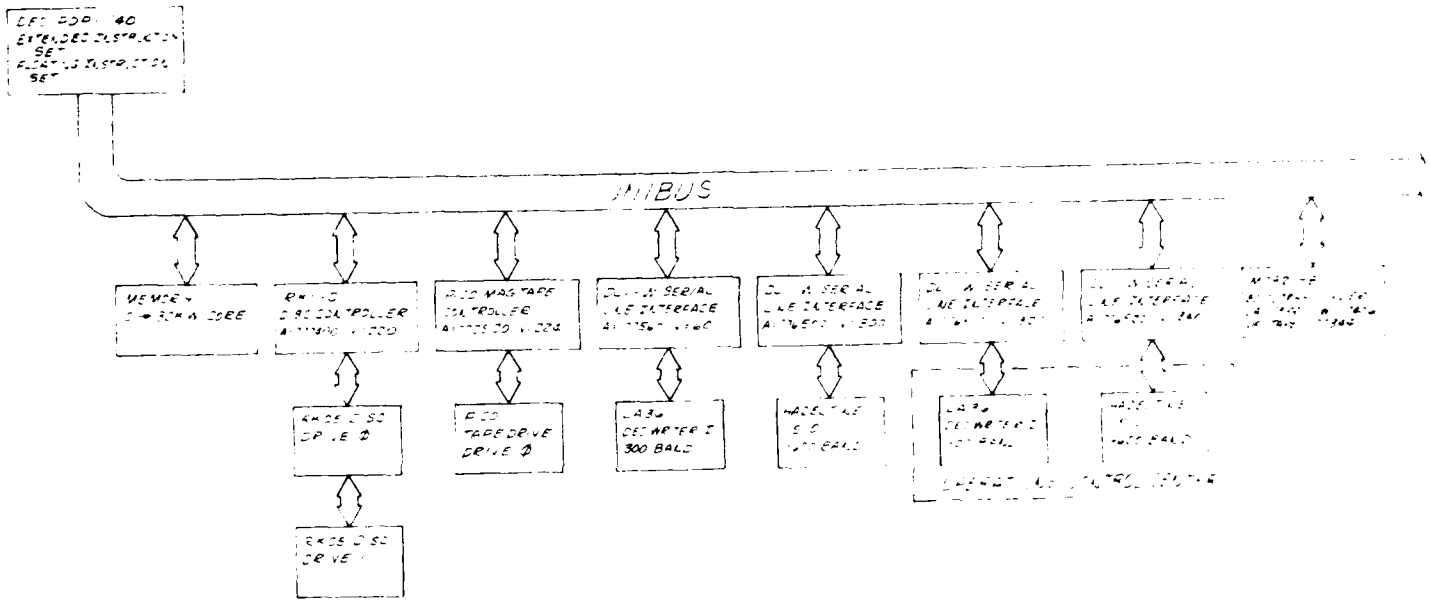
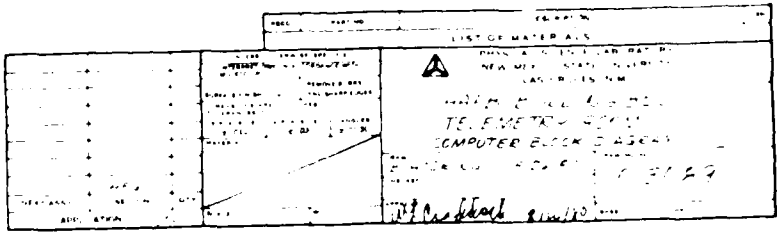

STEERABLE ALTELLA
STEERABLE ALTELLA
STEERABLE ALTELLA
PRE AMP
PRE AMP
MULTICOUPLER
MULTICOUPLER
RECEIVER
RECEIVER
RECEIVER
RECEIVER
RECEIVER
DOMSAT SUBSYSTEM

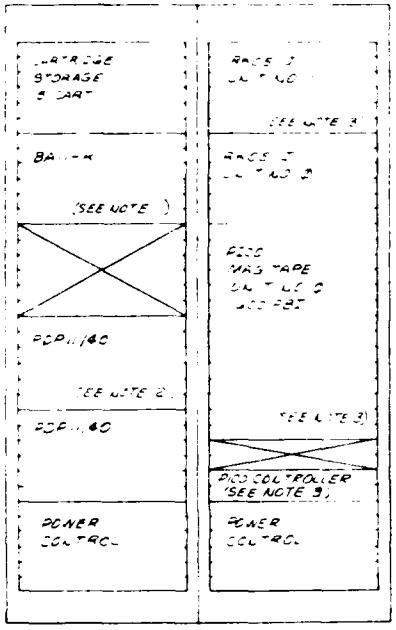
FIG. RE 7


LIST OF MATERIALS
NEW MEXICO STATE UNIVERSITY
LAS CRUCES, N.M.
HAFB BUILDING EEC
DATA RECEIVING SUBSYSTEM
01332




UNIBUS
TAPE DRIVE
DRIVE 0


LIST OF MATERIALS
TELEMETRY
COMPUTER BLOCK DIAGRAM



NOTES:

1. INSTALLED BACKPLANES CONSIST OF: (1) DD11-DA, 9 SLOTS; (2) DD11-BK, 4 SLOTS, (1) EMR BDC BACKPLANE.

   DD11-DA SLOTS USED:
   (1) DL11-W, A=176520, V=360

   BDC SLOTS USED:
   (2) EMR 740 BUFFERED DATA CHANNELS

   DD11-BK NO SLOTS USED

2. INSTALLED BACKPLANES CONSIST OF: (1) DD11-B; RK11-D; MM11-UP, PROCESSOR

   A. THE DD11-B IS A 4 SLOT SMALL PERIPHIRAL CONTROLLER BACKPLANE. INSTALLED IN IT CURRENTLY ARE 3 DL11-W'S (TECH LA, 2 INTERFACES) SEE TABLE I AND 1 M792-YB WHICH IS A BOOTSTRAP LOADER.

   TABLE I

ADDRESS	VECTOR
776500	300
765 00	320
760560	60

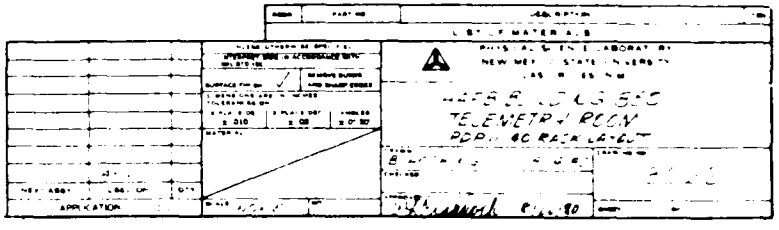
   B. RK11-D IS THE CONTROLLER FOR THE RK05 DISK DRIVE.

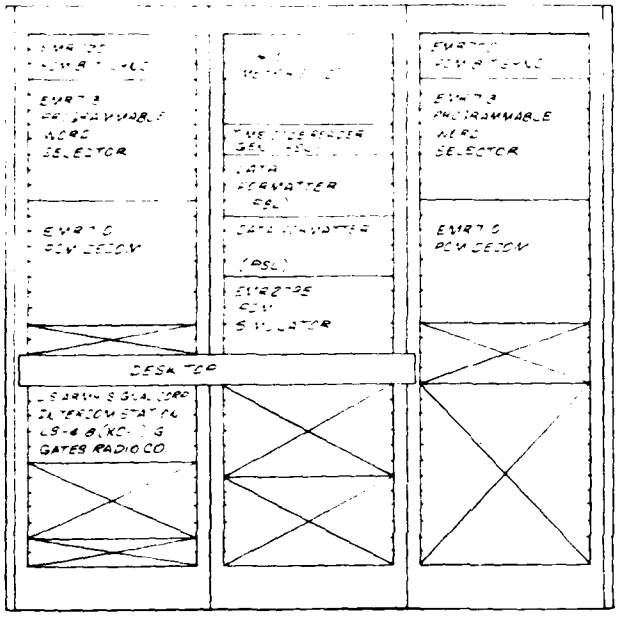
   C. THE MM-UP IS THE BACKPLANE AND 32KW OF CORE MEMORY

   D. THE PROCESSOR IS THE 40 COMPUTER

3. THESE UNITS MAY BE USED IN THE MOBILE VAN FOR FIELD REPAIR

4. ⊠ INDICATES BLANK PANEL



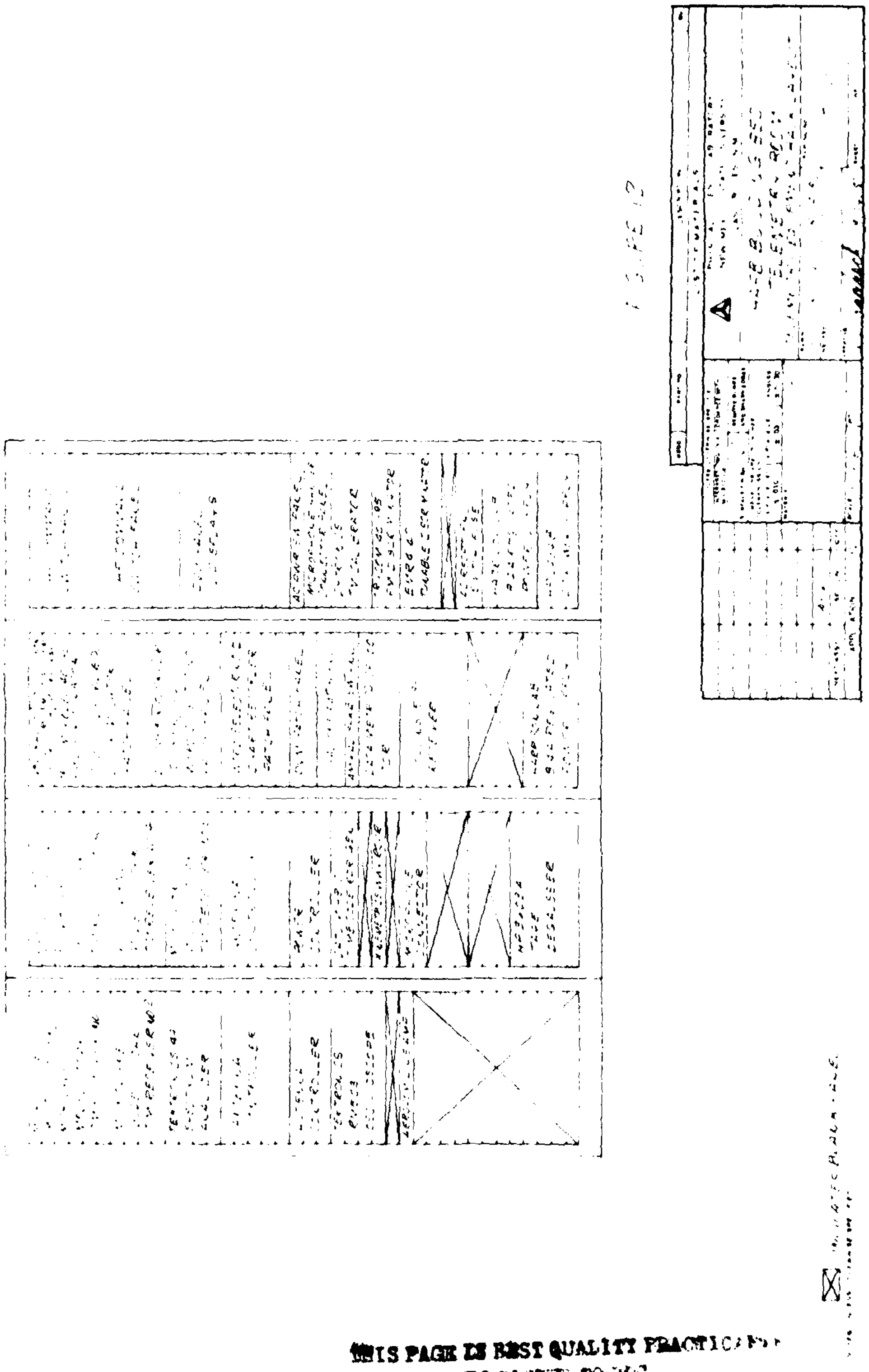


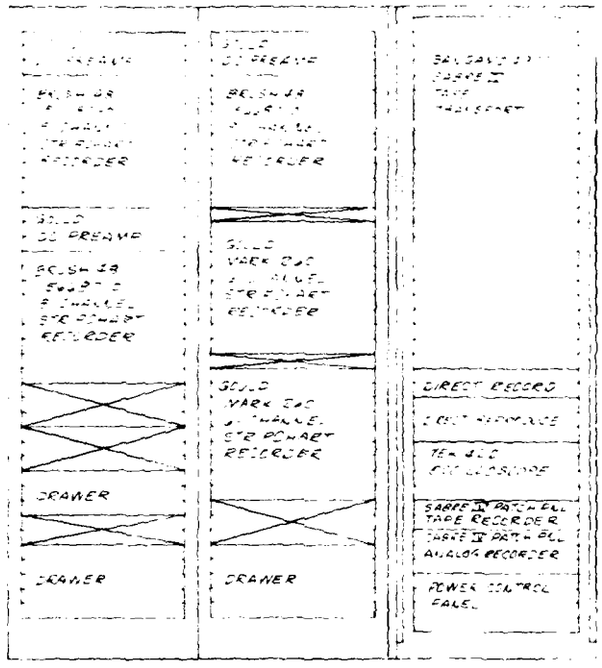
SIZE

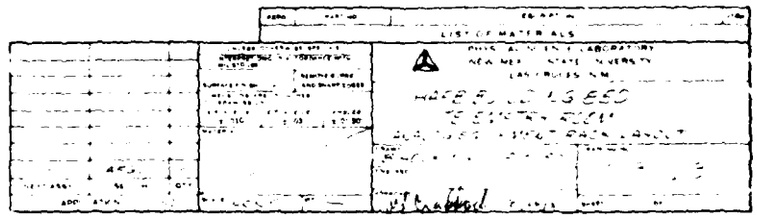
LIST OF MATERIALS

PHYSICAL SCIENCE LABORATORY
NEW MEXICO STATE UNIVERSITY
LAS CRUCES, N.M.

1 ☒ INDICATES BLACK PANEL
NOTES—UNLESS OTHERWISE SPECIFIED




DRAWER
DRAWER
DRAWER
DRAWER
DIRECT RECORD



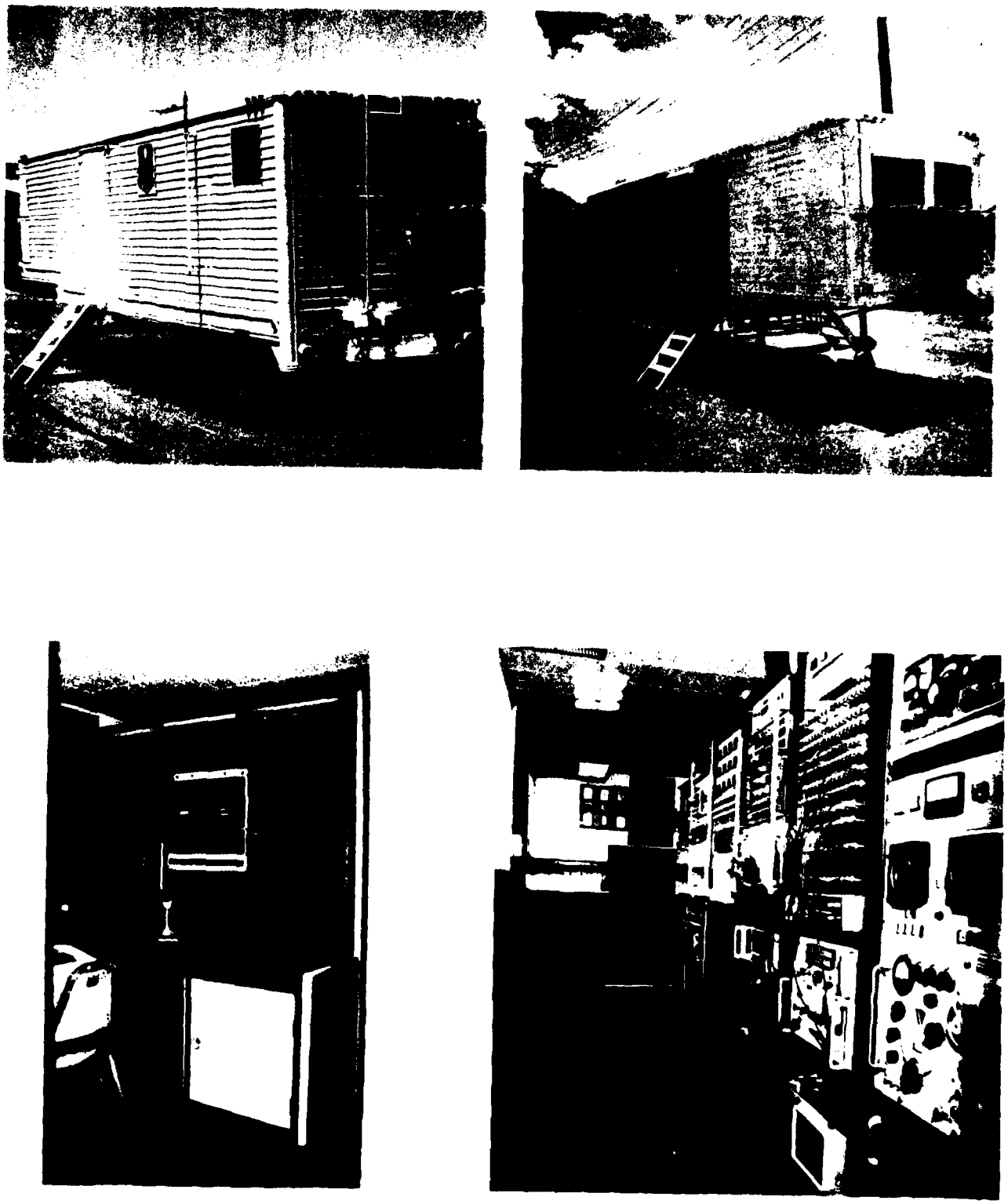


Figure 14 Mobile Facility

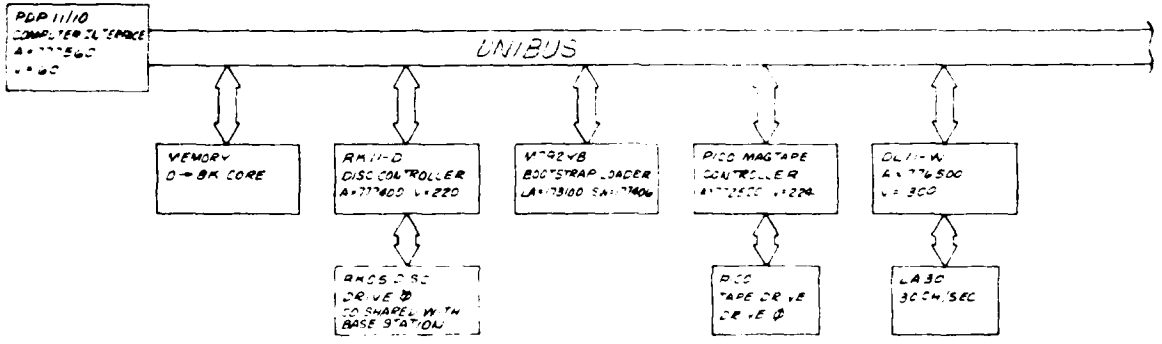


FIGURE 15

ITEM	PART NO	DESCRIPTION	MTRL
		LIST OF MATERIALS	

PHYSICAL SCIENCE LABORATORY
NEW MEXICO STATE UNIVERSITY
LAS CRUCES N M

AFGL MOBILE VAN
COMPUTER BLOCK DIAGRAM

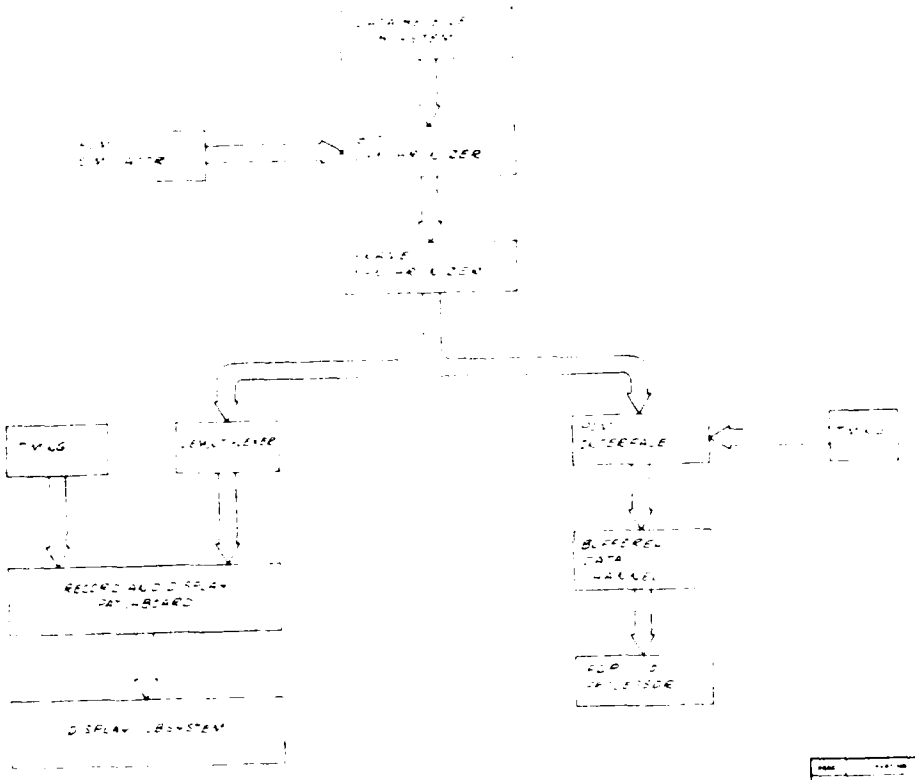
B HOCKING 8 26 80

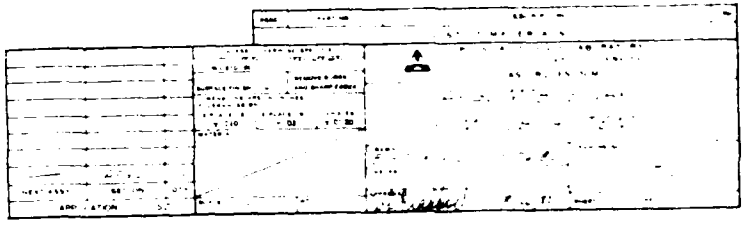
5 3087

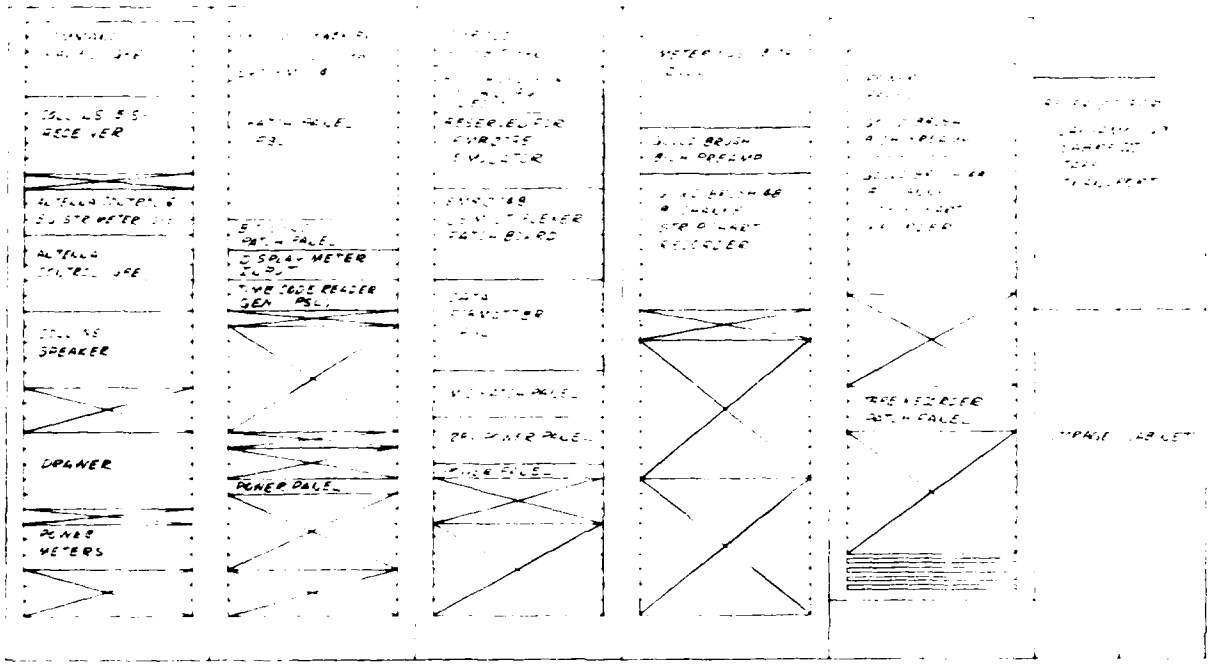
NEXT ASSY	USED ON	QTY
	AFGL	

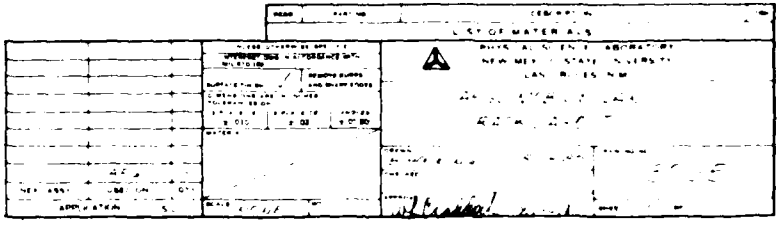
APPLICATION (SD)

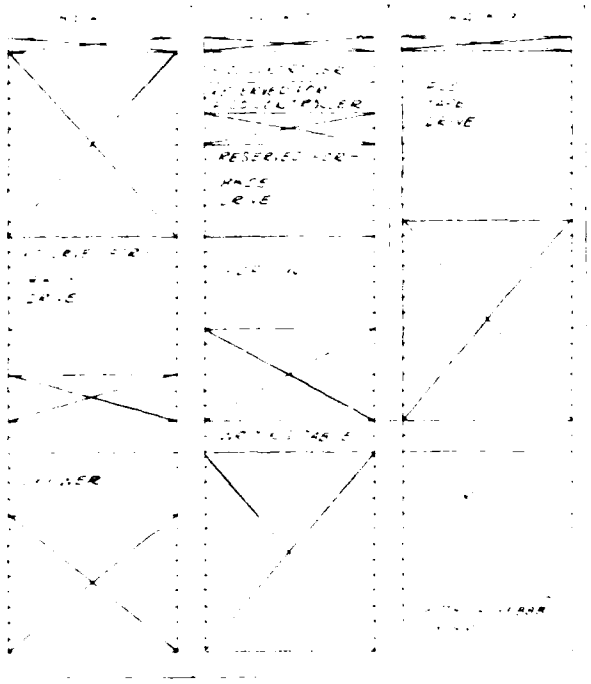
8/14/80

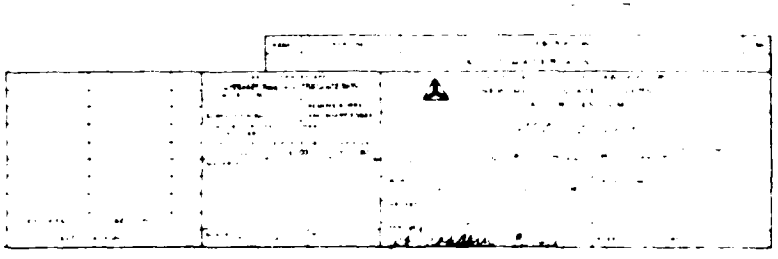


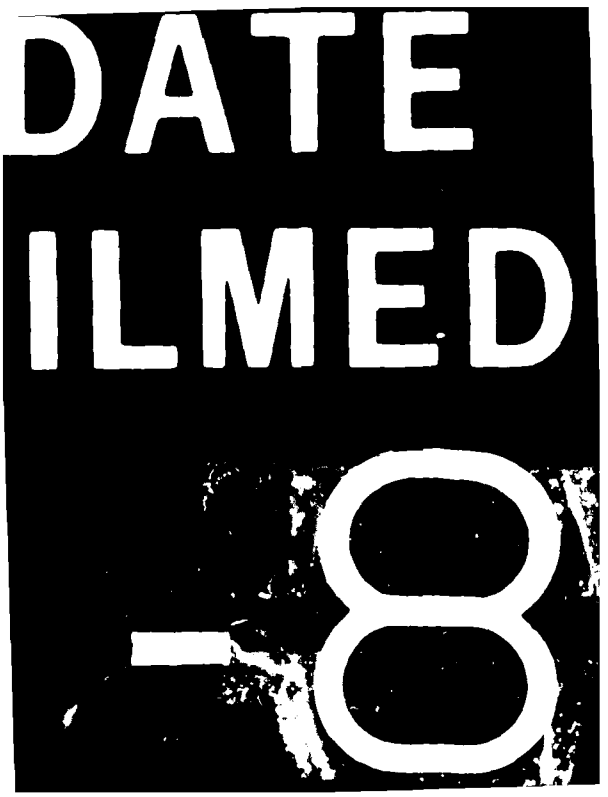



SPEAKER
DRAWER
METERS
METER BRUSH
SPEAKER








DATE
ILMED
-8